

CLAIMS

[1] A motor driver comprising:

a back electromotive force detection section that detects a back electromotive force appearing in a motor coil of a direct-current motor and outputs a detection signal; and

a speed control section that, based on the back electromotive force detected by the back electromotive force detection section, sets and outputs a current value of a drive current fed to the motor coil,

wherein the motor driver further comprises:

an offset calculation section

that first establishes a state in which the direct-current motor cannot be driven via the motor coil and thus no back electromotive force appears,

that then reads, as a first output, an output of the back electromotive force detection section as obtained when the current value of the drive current fed to the motor coil is made equal to zero,

that then reads, as a second output, the output of the back electromotive force detection section as obtained when the current value of the drive current fed to the motor coil is made equal to a predetermined value,

that then calculates, based on a difference between the first and second outputs, an offset that appears in the output of the back electromotive force detection section as a result of a change in an internal resistance of the motor coil, and

that then eliminates the offset by changing an amplification factor of the back electromotive force detection section.

- [2] The motor driver of claim 1,
 - wherein the back electromotive force detection section comprises:
 - a detection resistor of which one end is connected to one end of the motor coil;
 - a first resistor of which one end is connected to another end of the detection resistor;
 - a second resistor of which one end is connected to another end of the first resistor;
 - a first differential amplifier circuit
 - of which one input terminal is connected to a node between the first and second resistors,
 - of which an output terminal is connected to another end of the second resistor, and
 - of which another input terminal is connected to a node between the motor coil and the detection resistor; and
 - a second differential amplifier circuit
 - of which one input terminal is connected to an output from the first differential amplifier circuit, and
 - of which another input terminal is connected to another end of the motor coil,
 - wherein the offset that appears in the output of the back electromotive

force detection section as the result of the change in the internal resistance of the motor coil is eliminated by the offset calculation section varying the second resistor by a resistance value proportional to the difference between the first and second outputs.

[3] The motor driver of claim 2,
 wherein the back electromotive force detection section further comprises:
 an analog/digital conversion circuit that performs analog/digital conversion so that an output, in a range from zero to V_c , from the second differential amplifier circuit is converted into an n-bit digital signal, and
 wherein,
 let an initial value of a resistance value of the second resistor be R_x ,
 let the first output outputted from the analog/digital conversion circuit be X_1 , and
 let the second output outputted from the analog/digital conversion circuit be X_2 , then,
 when the predetermined value to which the drive current is made equal to is positive, a resistance value of the second resistor is set to be $R_x \times (1 - (X_2 - X_1) / 2n - 1)$, and,
 when the predetermined value to which the drive current is made equal to is negative, the resistance value of the second resistor is set to be $R_x \times (1 + (X_2 - X_1) / 2n - 1)$.

[4] The motor driver of claim 3,
wherein the second resistor is composed of
n resistors connected in series and having resistance values of $R_x/20$,
 $R_x/21$, $R_x/22$, . . . , $R_x/2n-2$, and $R_x/2n-1$, respectively, and
n switches connected in parallel with the n resistors, respectively, and
wherein
the offset calculation section outputs an n-bit digital signal, of which a
k-th bit as counted from a highest bit is used to turn on and off, in the
second resistor, the switch connected parallel with the resistor having a
resistance value of $R_x/2k-1$, and,
when the predetermined value to which the drive current is made
equal to is positive, the offset calculation section outputs an n-bit digital
signal corresponding to $2n - 1 - (X_2 - X_1)$ to the n switches of the second
resistor, and,
when the predetermined value to which the drive current is made
equal to is negative, the offset calculation section outputs an n-bit digital
signal corresponding to $2n - 1 + (X_2 - X_1)$ to the n switches of the second
resistor.

[5] The motor driver of claim 3,
wherein
let an absolute value of the predetermined value to which the drive
current is made equal to be I_o ,
let a resistance value of the detection resistor be R_s ,

let a resistance value of the first resistor be R₁, and
let an amplification factor of the second differential amplifier circuit
be A, then

a relationship

$$V_C = A \times I_o \times R_s \times (2R_x) / R_1$$

is fulfilled.

[6] The motor driver of claim 4,
wherein the second resistor is composed of
n resistors connected in series and having resistance values of Rx/20,
Rx/21, Rx/22, . . . , Rx/2n-2, and Rx/2n-1, respectively, and
n switches connected in parallel with the n resistors, respectively, and
wherein
the offset calculation section outputs an n-bit digital signal, of which a
k-th bit signal as counted from a highest bit is used to turn on and off, in the
second resistor, the switch connected parallel with the resistor having a
resistance value of Rx/2k-1, and,
when the predetermined value to which the drive current is made
equal to is positive, the offset calculation section outputs an n-bit digital
signal corresponding to $2n - 1 - (X_2 - X_1)$ to the n switches of the second
resistor, and,
when the predetermined value to which the drive current is made
equal to is negative, the offset calculation section outputs an n-bit digital
signal corresponding to $2n - 1 + (X_2 - X_1)$ to the n switches of the second

resistor.

[7] The motor driver of claim 1,
 wherein the motor driver further comprises a subtraction section that
 eliminates the offset appearing when no back electromotive force appears,
 and

 wherein

 a difference between a third output outputted from the back
 electromotive force detection section when no back electromotive force
 appears and the first output is stored, in the offset calculation section, as the
 offset appearing when no back electromotive force appears, and

 a value obtained by subtracting from the output of the back
 electromotive force detection section the difference between the third and
 first outputs as stored in the offset calculation section is outputted as the
 detection signal.

[8] The motor driver of claim 1,
 wherein the back electromotive force detection section and the speed
 control section are built into a single semiconductor integrated circuit device.

[9] The motor driver of claim 7,
 wherein
 the detection signal from the back electromotive force detection
 section is outputted to an external control circuit, and

a value calculated by the control circuit based on the detection signal is inputted to the speed control section.

[10] A magnetic disk apparatus comprising:

- the motor driver of one of claims 1 to 9;
- the direct-current motor driven and controlled by the motor driver;
- a magnetic head that moves in a direction of a radius of the magnetic disk by being fed with a driving force of the direct-current motor;
- a spindle with a center of which the magnetic disk is engaged; and
- a ramp area that is provided outside the magnetic disk and in which the magnetic head is stored away,

wherein,

- when the magnetic head is kept in contact with the spindle or an inner wall of the ramp area, an offset that appears in the output of the back electromotive force detection section as the result of the change in the internal resistance of the motor coil of the direct-current motor is calculated by the offset calculation section, and
- the offset is eliminated by changing the amplification factor of the back electromotive force detection section.